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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/905,349	07/13/2001	Jay Brian DeDontney	A-67178-1/MSS	7344

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EXAMINER	
ZERVIGON, RUDY	
ART UNIT	**PAPER NUMBER**
1763	
MAIL DATE	**DELIVERY MODE**
06/07/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No.	Applicant(s)
	09/905,349	DEDONTNEY ET AL.
	Examiner	Art Unit
	Rudy Zervigon	1763

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 December 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1 and 4-11* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1 and 4-11* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *16 January 2002* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on December 8, 2006, and the grant on petition of April 25, 2007 are entered.

Claim Rejections - 35 USC § 103

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

3. Claims 1, 4, 5, 8, and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soichiro Kawakami (JP61037969) in view of Ohashi (JP10-177960)[1]. Soichiro Kawakami teaches a gas delivery metering tube (Figure 1) for delivering a gas in a plasma CVD process comprising:

i. an elongated outer tube (3) having an inlet end (4/3 interface) and a closed end (opposite end), and one or more arrays of orifices (15) formed in the elongated outer tube (3) and extending along the substantial length of the elongated outer tube (3); an elongated inner tube (5) having open inlet (4/5 interface) and outlet (opposite 4/5 interface) ends, the elongated inner tube (5) being nested and axially aligned inside of the elongated outer tube

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[1] Machine translation from http://www1.ipdl.jpo.go.jp

(3) forming an effective annular space (20) there between, and wherein the outlet end of the elongated inner tube (5) terminates prior to the closed end (opposite end) of the elongated outer tube (3).

Soichiro Kawakami further teaches the gas delivery metering tube further comprising a single gas supply port (inherent, feeding item 5, Figure 1) coupled to the inlet end (at cut away of item 5) of the elongated inner tube (5) for supplying gas to the metering tube.

Soichiro Kawakami does not teach:

i. a gas flow divider positioned adjacent the inlet ends of the elongated inner and outer tubes (5,3) and having a first gas flow path coupled to the elongated inner tube (5) and a second gas flow path coupled to the annular space (20) between the elongated inner and outer tubes (3,5).

ii. Soichiro Kawakami's gas delivery metering tube wherein the cross sectional area of the inside of the elongated inner tube (5) is approximately equal to the total cross sectional area of the plurality of small orifices in a flow divider

iii. Soichiro Kawakami's inner tube (5) extends a distance at least encompassing the arrays of orifices in the outer tube (3)

iv. Soichiro Kawakami's array of orifices (15) formed in the elongated outer tube (3) are configured to establish uniform backing pressure with Soichiro Kawakami's annular space (20), as claimed by amended claim 1 - However, when the structure recited in the reference is substantially identical to that of the claims (see Applicant's Figure 5, 6a; [0031]), claimed properties or functions are presumed to be inherent (In re Best, 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977); MPEP 2112.01).

Ohashi teaches a fluid flow divider (upper portion of 41, Figure 4) having a first flow path ("Sz") and a second gas flow path (Sx) coupled to an annular space (Sx). Ohashi further teaches the fluid flow divider being a disk (Figure 4) having a central orifice (17a) forming the first gas flow path and a plurality of small orifices (17b) forming the second gas flow path.

Ohashi further teaches a gas flow divider (upper portion of 61, Figure 6) which comprises a flange (see L shape of U/21 face, Figure 6) on the inlet end of the elongated inner tube (21, Figure 6), the flange having a lip (20, Figure 6) containing a plurality of small orifices (20a, Figure 6) forming the second gas flow path.

It would have been obvious to one of ordinary skill in that art at the time the invention was made to replace Soichiro Kawakami's support plate (4) with Ohashi's fluid flow divider, with an optimal number of orifice (17a), including optimizing the dimension(s) of Soichiro Kawakami's gas delivery metering tube and inner tube.

Motivation to replace Soichiro Kawakami's support plate (4) with Ohashi's fluid flow divider, with an optimal number of orifice (17a), including optimizing the dimension(s) of Soichiro Kawakami's gas delivery metering tube and inner tube as taught by Ohashi is for preventing particle adherence as taught by Ohashi ([0003], [0004]; Machine Translation) in Soichiro Kawakami's reactor (Figure 3). Further, motivation to dimension Soichiro Kawakami's gas delivery metering tube and inner tube wherein the cross sectional area of the inside of the elongated inner tube is approximately equal to the total cross sectional area of the plurality of small orifices in the flow divider is to provide for the desired pressure gradient. Further, it is well established that changes in apparatus dimensions are within the level of ordinary skill in the art.(Gardner v. TEC Systems, Inc. , 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), cert.

denied , 469 U.S. 830, 225 USPQ 232 (1984); In re Rose , 220 F.2d 459, 105 USPQ 237 (CCPA 1955); In re Rinehart, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976); See MPEP 2144.04)

4. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Soichiro Kawakami (JP61037969) and Ohashi (JP10-177960) in view of Ishii (USPat. 5,685,942). Soichiro Kawakami and Ohashi are discussed above. Soichiro Kawakami and Ohashi do not teach:

i. a gas supply port comprising a block having a pocket formed therein, the pocket being sealed with a cover to create a confined passage, and a gas supply connector coupled to the pocket for receiving a gas and a hollow tube assembly coupled to the pocket and the inlet end (4/3 interface) of the inner and outer tube (3)s for conveying the gas.

Ishii teaches gas delivery system (91, 89, 85; Figure 4) for a wafer processing apparatus (column 3, lines 37-49). Specifically, Ishii teaches:

ii. a gas supply port (91; column 8, lines 16-22) comprising a pipe {block} having a pocket (conduit volume) formed therein, the pocket being sealed with a cover (pipe 91) to create a confined passage (conduit volume), and a gas supply connector (92) coupled to the pocket for receiving a gas and a hollow tube (89) assembly coupled to the pocket

It would have been obvious to one of ordinary skill in that art at the time the invention was made to replace the gas conduit of Soichiro Kawakami and Ohashi with Ishii's gas supply port comprising a block instead of a pipe shape.

Motivation to replace the gas conduit of Soichiro Kawakami and Ohashi with Ishii's gas supply port comprising a block instead of a pipe shape is to provide an alternate and equivalent means for process gas delivery. Additionally, it has been established that the shape of a container is a

matter of choice which a person of ordinary skill in the art would have found obvious absent persuasive evidence that the particular configuration of the claimed container is significant (In re Dailey, 357 F.2d 669, 149 USPQ 47 (CCPA 1966); MPEP 2144.04).

5. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Soichiro Kawakami (JP61037969) and Ohashi (JP10-177960) in view of Lemp (USPat. 4,836,246). Soichiro Kawakami and Ohashi are discussed above. However Soichiro Kawakami and Ohashi do not teach one or more standoff spacers attached to the elongated inner tube to axially align the elongated inner tube inside the outer tube.

Lemp teaches a similar gas distribution arrangement (Figure 1; column 2, lines 24-40). Specifically, Lemp teaches a standoff spacer (16, Figure 1) attached to the elongated inner tube (32) to axially align the elongated inner tube (32) inside the outer tube (12).

It would have been obvious to one of ordinary skill in that art at the time the invention was made to add a standoff spacer attached to the elongated inner tube to axially align the elongated inner tube inside the outer tube in the Soichiro Kawakami and Ohashi apparatus as taught by Lemp.

Motivation to add a standoff spacer attached to the elongated inner tube to axially align the elongated inner tube inside the outer tube in the Soichiro Kawakami and Ohashi apparatus as taught by Lemp is to support the elongated inner and outer tubes (column 2, lines 35-40).

6. Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soichiro Kawakami (JP61037969) and Ohashi (JP10-177960) in view of DeDontney, Jay B. et al (USPat. 5,849,088). Soichiro Kawakami and Ohashi are discussed above. Soichiro Kawakami and Ohashi do not teach at least one injector assembly having at least one port for receiving the gas

delivery metering tube. Soichiro Kawakami and Ohashi do not teach at least one shield assembly having at least one plenum for receiving the gas delivery metering tube.

DeDontney teaches a similar gas delivery system (Figure 3; column 5, line 61 – column 6, line 34). Specifically, DeDontney teaches an injector (14, Figure 3) and at least one shield assembly (40c,d; Figure 4) having at least one plenum (78) for a gas delivery metering tube (80).

It would have been obvious to one of ordinary skill in that art at the time the invention was made to provide a port in DeDontney's injector assembly for Soichiro Kawakami' and Ohashi's gas delivery metering tube including replacing DeDontney's gas delivery metering tube with Soichiro Kawakami's and Ohashi's gas delivery metering tube.

Motivation to provide a port in DeDontney's injector assembly for Soichiro Kawakami' and Ohashi's gas delivery metering tube including replacing DeDontney's gas delivery metering tube with Soichiro Kawakami's and Ohashi's gas delivery metering tube is to distribute process gas as taught by Soichiro Kawakami.

Response to Arguments

7. Applicant's arguments filed December 8, 2006 have been fully considered but they are not persuasive.

8. Applicant states:

"

Applicants maintain the position that there are no motivation and no likelihood of success in combining Soichiro with Ohashi, and no suggestion in either reference for such as combination. The object of Soichiro is to overcome the shortcomings of the conventional plasma CVD apparatus shown in FIG. 4 in Soichiro, which is reproduced below. The conventional plasma

CVD apparatus has coaxial electrodes including a cathode la and a counter electrode (not shown) facing the cathode 1a and serving as a support for a substrate on which a thin film is formed by deposition. The peripheral wall of the cathode is provided with a plurality of gas-spraying openings 7a disposed at regular intervals in the peripheral and axial directions.

"

9. In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988)and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, the Examiner believes the proposed motivation, found in the references themselves, to replace Soichiro Kawakami's support plate with Ohashi's fluid flow divider, is taught by Ohashi because Ohashi's flow divider is employed for preventing particle adherence ([0003], [0004]; Machine Translation) during gas distribution. Such a particle adherence would deteriorate the flow characteristics resulting in uneven film processing as well as particulate contamination as discussed repeatedly in the machine translation of Ohashi. Indeed, the above proposed combination results in a gas flow divider configured to divide gas from a single gas supply port (Ohashi's 19) coupled to one end of Soichiro Kawakami's gas delivery metering tube.

10. Applicant states:

"

This rejection is respectably traversed. Applicants see no motivation or suggestion in either of the references for such a combination. Reaction gases do not usually form particles before they are introduced into the reaction chamber, where heat or plasma enhancement cause reactions to happen. Otherwise, the gas tubes, such as the tube 5, for supplying the reactions gases would be easily congested and have to be constantly flushed to get rid of the particles. The problems of the gas eddy flow and the "disturbance of gas" in Ohashi, which happens in the reaction chamber 71, simply do not occur within the cathode 1 in Soichiro because Soichiro employs neither a heater nor a rotating element in the cathode 1 to cause such problems. What Soichiro really attempts to do is to carefully design the gas flow paths through the layered openings 13, 14, and 15 in the partitions 2 and 3 and the cathode 1 so that reaction gas may be introduced uniformly into the reaction chamber through the cathode 1. It is unreasonable to assume that Soichiro would take the approach of Ohashi by blowing the non-reacted reaction gas away through some exhaust before the gas ever gets out of the cathode 1, in order to avoid particle formation in the cathode 1.

"

11. In response, the Examiner disagrees. In particular, the Examiner takes issue with Applicant's statement that "Reaction gases do not usually form particles before they are introduced into the reaction chamber". This statement is completely antithetical to *chemical vapor deposition* apparatus, plasma or nonplasma, which require reactivity among reactants to react and nucleate on the substrate and deposit films of desired compositions (See Ohashi - [0003], [0004]; Machine Translation). That Ohashi is specific in stating that the problem to be

solved (abstract) in his apparatus is to prevent particles from attaching is a gleaming example of such a deposition mechanism (See Ohashi - [0003], [0004]; Machine Translation).

12. Applicant states that there is no reasonable likelihood of success because:

"

if there were problems with particle formation within the cathode 1 because of the introduction of the reaction gas into the buffers 18, 19, and 20 through tube 63 and the openings 14 and 15 in the partitions 2 and 3, there is no reason to assume that introducing the same reaction gas through the cathode support plate 4 would make any difference in particle formation. Moreover, introducing gas into the spaces between the cathode 1 and partition 2, the partitions 2 and 3, and/or the partitions 3 and 62 from the bottom of the partitions would disturb the gas flow paths carefully designed in Soichiro, destroy the gas distribution uniformity Soichiro attempts to achieve, and defeat the purpose of the invention in Soichiro. As shown in FIG. 1 in Soichiro, which is reproduced above, if the reaction gas is introduced into the buffers 18, 19, and 20 through the cathode support plate 4, more reaction gas will get through the openings 13, 14, and 15 near the cathode support plate 4.

"

In response, the Examiner disagrees. In particular if Kawakami were to use the same processing gasses as Ohashi, the Examiner argues that the same, if not more intense, particulate problem that Ohashi is trying to avoid would be even more pronounced in the apparatus of Kawakami due to Kawakami's more intricate and circuitous flow pattern(s) resulting, prior to the combination, in what Ohashi discusses as "vortices" that create sources for particulate formation (Ohashi [0020]).

13. Applicant states:

"

...the top portion of the reactor 41 in Ohashi is not a gas flow divider. A gas flow divider, as commonly known and as recited in Claim 1, should divide a gas flow from a single gas supply port into a plurality of gas flow paths into separate areas.

"

14. In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., see above) are not recited in the rejected claims. Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). Further, the broadest reasonable interpretation of "a gas flow divider" is believed to be encompassed by Ohashi's upper portion of reactor 41 which shows gases divided, not mixed. Further:

15. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Conclusion

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Examiner Rudy Zervigon whose telephone number is (571) 272.1442. The examiner can normally be reached on a Monday through Thursday schedule from

8am through 7pm. The official fax phone number for the 1763 art unit is (703) 872-9306. Any Inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Chemical and Materials Engineering art unit receptionist at (571) 272-1700. If the examiner can not be reached please contact the examiner's supervisor, Parviz Hassanzadeh, at (571) 272-1435.

5/1/7

Notice of References Cited	Application/Control No. 09/905,349	Applicant(s)/Patent Under Reexamination DEDONTNEY ET AL.	
	Examiner Rudy Zervigon	Art Unit 1763	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-			
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
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	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

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	N					
	O					
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	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Machine Translation of 10177960 from http://www4.ipdl.inpit.go.jp/Tokujitu/PAJdetail.ipdl?N0000=60&N0120=01&N2001=2&N3001=H10-177960
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

* NOTICES *

Machine Translation of
10-177960

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] About vapor growth equipment and the vapor growth approach, in detail, there is little generating of the sludge to the particle and the furnace wall in the gaseous phase applied to the production process of the semi-conductor wafer substrate with which high quality is demanded, the thin film of uniform thickness is formed, and this invention does not have dispersion in resistance, it is homogeneous and relates to the vapor growth equipment and the vapor growth approach that a semi-conductor wafer substrate with few crystal defects is obtained.
[0002]
[Description of the Prior Art] Drawing 7 is the gas flow rate distribution map (B) of each perpendicular direction in the predetermined locations B, C, and D shown in (A) in the approximate account Fig. (A) showing an example of conventional vapor growth equipment, and its equipment, (C), and (D). In addition, the segment with the arrow head in (A) is the gas elementary-stream Fig. having shown the gas stream in equipment typically. In drawing 7 (A), generally, the revolving shaft 73 for rotating the rotation substrate electrode holder 72 and the rotation substrate electrode holder 72 which lay the wafer substrates W, such as a silicon wafer, and the heater 74 for heating are arranged by the lower part in the cylinder-like fission reactor 71, and the motor (not shown) which carries out a rotation drive is connected to the revolving shaft 73 at it. Moreover, two or more exhaust ports 75 and 75 which exhaust a unconverted gas etc. are arranged in fission reactor 71 pars basilaris ossis occipitalis, and it connects with the exhaust air control unit (not shown). On the other hand, two or more gas supply lines 76 and 76 which supply the reactant gas of material gas or carrier gas in a furnace, and the disc-like straightening vane 77 are arranged by the crowning of a fission reactor 71, and hole 77a of a large number which prepare the flow of gas is drilled by the straightening vane 77. Conventional vapor growth equipment is constituted as mentioned above, and the substrate W laid on the rotation substrate electrode holder 72 which rotates at a predetermined rotational frequency by the rotation drive of a motor is heated by predetermined temperature at a heater 74, rotating. Much hole 77a of a straightening vane 77 is passed so that the gas flow rate distribution in a fission reactor may become subsequently to homogeneity, reactant gas is supplied to homogeneity and it is made to introduce reactant gas, such as material gas and carrier gas, through two or more gas supply lines 76 and 76 in a fission reactor 71, to equalize gas momentum and pressure distribution to coincidence, and to carry out vapor growth of the thin film to the wafer substrate W on the rotation substrate electrode holder 72.
[0003] In the vapor growth equipment which forms a thin film in up to a semi-conductor wafer which was described above, various kinds of proposals are made as a crystal defect does not arise more inconvenient [at the time of thin film formation] so that [in order to prevent generating of the particle by thin film formation gas, and adhesion of a sludge in a fission reactor wall, and] a thin film formation wafer with uniform thickness with a homogeneous and thin film may be obtained. For example, prevention of a crystal defect is aimed at by controlling the supply flow rate of material gas by JP,5-74719,A to predetermined, and preventing the temperature change in a fission reactor. In JP,5-90167,A, the rotational frequency of the amount of material gas, furnace internal pressure, and a rotation substrate holder etc. is controlled to predetermined, and prevention of a slip is aimed at so that distribution may be made into homogeneity whenever [field internal temperature / of the wafer substrate at the time of thin film formation]. In JP,6-216045,A, while making easy fission reactor washing after maintaining inner skin flat and smooth to some fission reactor walls which a sludge tends to produce, arranging a shielded tube and performing thin film formation actuation, a gas stream is maintained in the laminar-flow condition, and formation of a homogeneous thin film is aimed at. Moreover, in JP,7-50260,A, while performing installation of the material gas to the straightening-vane top which has two or more holes, or carrier gas through two or more supply pipes in the fission reactor upper part, by making the inflow direction predetermined, gas momentum and gas pressure are made into homogeneity, material gas etc. is

supplied on a substrate by the uniform rate of flow, and equalization of thin film thickness is attained.
[0004]
[Problem(s) to be Solved by the Invention] However, in the conventional vapor growth equipment of the various above-mentioned proposals, by the time a crystal defect can arise or un-arranging, such as particle adhesion, can fully prevent with the wafer substrate which carried out thin film growth, it will not have resulted. Moreover, since quality improvement came to be increasingly required with the super-high integration especially in a semi-conductor in recent years, the wafer substrate becomes [the debasement of few / a thin film formation wafer substrate / defects] a problem more often. In view of the debasement of the wafer substrate in the vapor growth thin film formation by such conventional vapor growth equipment, this invention is made in order to solve them. Artificers examined first the phenomenon produced with conventional vapor growth equipment in the detail. Consequently, the phenomenon in which particle adhered to a fission reactor wall mostly was observed, therefore the maintenance cycle was shortened, and the particle adhering to this fission reactor wall adhered to the wafer substrate, and the knowledge of being the cause of bringing about deterioration of wafer quality directly as adhesion particle was carried out [**** / becoming the cause of a crystal defect].
[0005] From the above-mentioned knowledge, further, artificers examined the material gas flow in a fission reactor etc so that they may find out the cause of the particle abundant attachment phenomenon in a fission reactor wall. Consequently, it became still clearer that the phenomenon which carries out the following arises in a fission reactor. That is, in the conventional fission reactor 71 shown in ** above-mentioned drawing 7 , since the fission reactor lower part is heated at the heater 74 at the same time reactant gas, such as silicon material gas, is introduced from a crowning it is supplied on the wafer substrate W by the uniform rate of flow and thin film formation is presented, the heating temperature up also of the reactant gas which reached near the wafer substrate W is carried out. Consequently, althougl gas flows down by the almost uniform rate of flow in the (B) region in a furnace as the velocity distribution of the gas elementary-stream Fig. of (A) of drawing 7 and (B), (C), and (D) showed, in the (C) region, a gas flow rate falls near a furnace inner circle wall, and a gas stream changes to upward flow along with a fission reactor inner circle wall in the (D) region. For this reason, the dancing going-up phenomenon of reactant gas arises, and generating of a gas vortex takes place. ** Since the warmed reactant gas goes up again, the temperature of the whole region in a fission reactor 71 also rises, the homogeneous nucleation of the thin film formation material gas in the inside of a gaseous phase increases, and particle generating in a gaseous phase increases. ** Further, if the above-mentioned gas vortex occurs, there will be a possibility that re-taking in of the dopant in reactant gas may take place in the periphery section of the wafer substrate W on the rotation substrate electrode holder 72, and it will cause ununiformity-izing of the field interna resistance value distribution of the wafer substrate obtained.
[0006] Extent whose generating of the gas vortex which causes various kinds of above-mentioned un-arranging is a thing of about 1 or more m/s made very quick about the gas flow rate to the shaft orientations of a rotation substrate supporter in the conventional fission reactor can be controlled. However, it is necessary to pass a lot of carrier gas for that purpose, and becomes practicality with a scarce thing industrially. For this reason, that artificers mainly had inconvenient causes, such as debasement of the above mentioned thin layer formation wafer substrate, and short-period-izing of the maintenance cycle of a fission reactor, in generating of a gas vortex and the turbulence of a gas stream by the upward flow of the gas in a fission reactor, they inquired wholeheartedly so that they may prevent these gas vortex generating. Consequently, the numerical aperture of the straightening vane arranged in order to supply reactant gas on a rotation substrate supporter by the uniform rate of flow To having been equally adjusted to about 10% throughout the former from the ability of a rise gas stream to be effectively controlled by changing a numerical apertur in a predetermined field Abundant adhesion of particle in the above-mentioned abundant generating of particle, and a furnace wall, The deposit of a thin film formation component could be prevented, reduction of the crystal defect of a wafer substrate and the incorporation in the wafer periphery section of a dopant could be prevented by that cause, the crystal defect was quality few and header this invention was completed for the ability of the wafer substrate in which the thin film of homogeneous membrane thickness carried out vapor growth to be obtained.
[0007]
[Means for Solving the Problem] According to this invention, it has the rotation substrate supporter which lays an exhaust port in two or more reactant gas feed hoppers and a pars basilaris ossis occipitalis at the crowning of a fission reactor in the air, and lays a wafer substrate in the interior, and the straightening vane with which the head-lining section and a space region were formed in the internal upper part, and two or more gas eyes were drilled. In the vapor growth equipment to which supply reactant gas to the interior and the wafer substrate front face on a rotation substrate supporter is made to carry out vapor growth of the thin film, the vapor growth equipment characterized by being formed and becoming so that the gas flow rates of a center section and the periphery section in a furnace may differ is

a straightening vane may become larger than other fields (mainly central region) in the predetermined periphery region within a straightening-vane side, the reactant gas rate of flow in the downward fission reactor wall circumference can be made quicker than a straightening vane. A reactant gas style reaches near the wafer substrate front face on a rotation substrate supporter from this, it has the directivity to the direction of a path, and circulates, and unlike said conventional method, a unconverted gas circulates from the periphery side of a rotation substrate supporter smoothly tc the exhaust port of a fission reactor pars basilaris ossis occipitalis after that according to the gas stream of the high speed of the inner-wall-of-the-kiln circumference, without forming the upward flow along a furnace wall. Therefore, the temperature rise of the gas in a furnace is controlled, homogeneous nucleation decreases, particle generating is reduced, and formation of the crystal defect of the wafer substrate by particle adhesion in a furnace wall, a thin film formation component deposit, fall adhesion of adhesion particle, etc. can be prevented. Moreover, since smooth gas flow is maintained, the reuptake in the wafer substrate periphery section of a dopant can be prevented, and that of a wafer side internal resistance value also becomes uniform, and can obtain the thin film formation wafer substrate of high quality. Completely unlike having adjusted these so that the straightening vane arranged in the conventional fission reactor might carry out drilling formation of the gas eye with a numerical aperture equal in the whole region anc it might become the uniform rate of flow in the fission reactor of a straightening-vane lower part, it will not be proposed without this invention.

[0014]

[Embodiment of the Invention] Hereafter, the example of this invention is explained to a detail based on a drawing. However, this invention is not restricted by the following example. In addition, in the following example, although the fission reactor of cylindrical hollow with the circular horizontal section configuration of a fission reactor is explained for convenience, especially a horizontal section configuration may not be restricted and corniform etc. is sufficient as it Moreover, the same is said of a rotation substrate supporter. Generally, a cylindrical hollow fission reactor and a circular rotation substrate supporter are used suitably.

[0015] Drawing 1 is the gas flow rate distribution map (B) of each perpendicular direction in the predetermined locations B, C, and D shown in (A) in the outline cross-section explanatory view (A) of one example of the vapor growth equipment of this invention, and equipment, (C), and (D). In addition, the segment with the arrow head in (A) is the gas elementary-stream Fig. having shown the gas stream in equipment typically like aforementioned drawing 7 . Drawing 2 is the mimetic diagram of the straightening vane arranged by drawing 1 . In drawing 1 (A) and drawing 2 , a fission reactor 11 is constituted almost like the fission reactor of the above mentioned conventional vapor growth equipment, the body of revolution 12 which lays the wafer substrate W is supported free [rotation] with a revolving shaft 13 by the lower part in a furnace, and is arranged, and the heater 14 which heats the wafer substrate W laid body of revolution 12 and on it is arranged in the lower part. The motor (not shown) which carries out a rotation drive is connected to a revolving shaft 13. Moreover, two or more exhaust ports 15 and 15 which exhaust a unconverted gas etc. are arranged in fission reactor 11 pars basilaris ossis occipitalis. On the other hand, two or more gas supply openings 16 and 16 which supply the reactant gas which consists of carrier gas, such as material gas, such as a silane (SiH_4) and dichlorosilane (SiH_2Cl_2), and hydrogen (H_2), an argon (Ar), helium (helium), are arranged by the crowning of a fission reactor 11. In the upper part inside a fission reactor, the head-lining section and the predetermined space region S are held, and it is close to the inner skin of a fission reactor 11, and is arranged so that the reactant gas with which the disc-like straightening vane 17 with which two or more drilling of gas eye 17a of a minor diameter and the gas eye 17b of a major diameter was carried out, respectively is supplied may not carry out channeling.

[0016] In this invention, the straightening vane arranged in the upper part of the above-mentioned fission reactor flows much reactant gas which flowed from the gas supply openings 16 and 16 in a fission reactor from the drilled gas eyes 17a and 17b. In this case, unlike the uniform numerical aperture of the conventional straightening vane, a gas eye is suitably drilled so that the numerical aperture of the predetermined external region (X region) of a straightening vane 17 may become larger than a central field (it only considers as a central region or Z region hereafter) at the other field and the Lord. In this case, as for the ratio of an external region numerical aperture (OX) and a central region numerical aperture (OZ), it is desirable to make it become the ratio (VX/VZ) in which the rate of flow of reactant gas after passing the gas eye of each field and being rectified carries out a postscript. Usually, OX/OZ A ratio drills the gas eye of each region in 10-2600, respectively. Moreover, neither the hole configuration of a gas eye nor especially drilling arrangement is restricted, and can be suitably chosen according to the configuration and reaction condition of a fission reactor. for example, it was shown in drawing 1 and 2 -- as -- ****** -- there is a method to which a numerical apertur is changed by drilling the gas eye of the diameter of opening. In drawing 1 and drawing 2 , gas eye 17a of a minor diameter is arranged equally in the central region of a straightening vane 17, and gas eye 17b of a major diameter is arranged suitably in the external region. although opening of gas eye 17b of a major diameter shown in drawing 2 is the

offered.

[0008] In the vapor growth equipment of above-mentioned this invention, it is desirable to make it the gas flow rates of the center section in a furnace and the periphery section differ, as said straightening vane is close to a furnace inner circle wall and the numerical aperture of said gas eye becomes larger than other fields in the external region of the periphery edge of the projection configuration of said rotation substrate supporter by which an orthographic projection is carried out to the straightening vane to the direction of a path. Or it is desirable to make it the gas flow rates of the center section in a furnace and the periphery section differ, as said straightening-vane periphery edge and furnace inner circle wall have a gap and this straightening-vane periphery edge is located in the external region of the direction of a path from the periphery edge of the projection configuration of said rotation substrate supporter by which an orthographic projection is carried out to said straightening vane. Said external region has predetermined spacing width of face from said fission reactor inner circle wall in these cases, and 0.02-1.0, and that it is 0.05-0.5 preferably have a desirable ratio (X/Y) with the difference (Y=RD-RP) of said spacing width of face (X), said straightening-vane equivalent radius (RD), and equivalent radius (RP) of said projection configuration. Moreover, the horizontal section o said fission reactor is circular, and it is desirable that said straightening vane and said rotation substrate supporter are arranged concentrically. That is, it is desirable that the spacing width of face from the inner wall of the kiln of the external region in which the above-mentioned numerical aperture is greatly carried out, and the straightening-vane periphery edge which has furnace inner circumference and a gap is located is equal to the difference of each radius of a straightening vane and a rotation substrate supporter, or is in 0.02 or more times of the difference.

[0009] moreover , while at least 2 ****s of said space region be carry out by the batch member arrange in the external region of the direction of a path from the periphery edge of the projection configuration of said rotation substrate supporter by which an orthographic projection be carry out to said straightening vane in the interior , it be desirable in the vapor growth equipment of above-mentioned this invention for two or more reactant gas feed hoppers to be arrange by each partition , respectively , and to make it the gas flow rates of the center section in a furnace and the periphery section differ . Said external region has predetermined spacing width of face from said fission reactor inner circle wall in these cases, and 0.02-1.0, and that it is 0.05-0.5 preferably have a desirable ratio (X/Y) with the difference (Y=RD-RP) of said spacing width of face (X), said straightening-vane equivalent radius (RD), and equivalent radius (RP) of said projection configuration. Moreover, the horizontal section of said fission reactor is circular, and it is desirable that said straightening vane and said rotation substrate supporter are arranged concentrically. That is, it is desirable that the spacing width of face from the inner wall of the kiln of the external region in which a dashboard is arranged is equal to the difference of each radius of a straightening vane and a rotation substrate supporter, or is in 0.02 or more times of th difference. Moreover, it is desirable for a separate reactant gas supply network to be connected through said reactant gas feed hopper, and to make it the gas flow rates of the center section in a furnace and the periphery section differ for said every partition.

[0010] Furthermore, in the vapor growth equipment of above-mentioned this invention, the interior of hollow of a fission reactor is classified into the vertical section from which a considerable bore differs, a upside considerable bore is smaller than a lower considerable bore, and it can form so that an up lower limit and lower upper limit may be connected and the interior of hollow may continue.

[0011] Moreover, while according to this invention circulating said straightening vane and rectifying reactant gas using above vapor growth equipment, the vapor growth approach characterized by for the reactant gas rate of flow after circulation rectification turning into a high speed in said external region, and supplying it on the wafer substrate front face on said rotation substrate supporter from a field besides the above is offered. this vapor growth approach -- setting -- the gas flow rate (VX) of said external region -- said -- others -- it is desirable that the rate-of-flow ratio (VX/VZ) with the gas flow rate (VZ) of a field is in the range of 10-20 preferably by 5-30.

[0012] Furthermore, this invention is an approach to which make it flow down reactant gas on the wafer substrate with which reactant gas is supplied from the upper part, and support rotation of the lower part is carried out after rectification into a fission reactor in the air, and a wafer substrate front face is made to carry out vapor growth of the thin film, and offers the vapor-growth approach characterized by to supply reactant gas so that the gas flow rate (VX) of a fission reactor wall circumference region may become high-speed from the gas flow rate (VZ) of a wafer substrate upper part region after said rectification. In this vapor growth approach, it is desirable that the rate-of-flow ratio (VX/VZ) of the gas flow rate (VX) of a fission reactor wall circumference region and the gas flow rate (VZ) of a wafer substrate upper part region is in the range of 10-20 preferably by 5-30.

[0013] While equalizing the momentum and pressure distribution of gas by constituting this invention as mentioned above and supplying reactant gas, such as material gas and carrier gas, to a space region from two or more gas supply openings Since drilling arrangement of the gas eye is carried out so that the drilling numerical aperture of the gas eye o

configuration prolonged in the shape of an ellipse in the hoop direction -- a hole -- a circular hole and a square hole are sufficient as a configuration. Moreover, as shown in drawing 3 , the numerical aperture of an external region can also be enlarged by making [more] the number of drilling of the gas eye per unit area in an external region for gas eye 17c of the diameter of the same opening than a central region in the same configuration. Furthermore, the reactant gas which passed gas eye 17a of a central region in the case of which is rectified, and gas eye 17a drilled in the central region of the straightening vane of this invention is arranged almost equally so that it may flow down by the uniform rate of flow on the wafer substrate W front face on the rotation substrate supporter 12.

[0017] In this invention, the external region which enlarges the above-mentioned numerical aperture points out the fiel located in the direction of a path from the periphery edge P of the drawn projection configuration in which the rotation substrate supporter 12 arranged in a fission reactor lower part carries out an orthographic projection, as shown in drawing 2 . Namely, radius RP of the projection configuration drawn by the orthographic projection of the disc-like rotation substrate supporter 12 It is equal to the radius (RS) of the rotation substrate supporter 12. The boundary of the external region of this invention and a central region is the straightening-vane radius RD. Radius RP of a projection configuration It is made whether it is equal to Difference Y (= RD-RP), and to become from it. That is, the boundary o an external region and a central region is X<=Y, when it has the spacing distance (width of face) X from the inner wall of the kiln to which the straightening-vane periphery section, i.e., a straightening vane, is close, and it has distance Z from a core and it is located. Therefore, it is Z=RP if it is X=Y. In accordance with the periphery edge P of a projection configuration, if it is X<Y, it is Z>RP. It is located in the direction of a path from the periphery edge P. Furthermore, it is desirable the range of 0.02-1.0 (0.02 <=X/Y>=1.0) and that a ratio with the above-mentioned difference Y carries ou to the spacing width of face X of an external region as [become / preferably / the range of 0.05-0.5]. In accordance with a fission reactor wall, the dancing going-up phenomenon to the upper part of a gas stream arises that this X/Y rati is less than 0.02, and generating of a gas vortex cannot be controlled. On the other hand, if 1.0 is exceeded and it is a big numerical aperture into the periphery edge P of the above-mentioned projection configuration, the reactant gas styl which has a suitable uniform velocity distribution in the fission reactor to a rotation substrate supporter cannot be obtained, and the thin film formation wafer substrate of high quality without a crystal defect cannot be manufactured.

[0018] In the vapor growth equipment of this invention, as the straightening vane arranged in the upper part in a fission reactor was described above, drilling formation of the gas eye is carried out so that a numerical aperture may become large from a central region (Z region) in an external region (X region), and the gas eye of a central region is arranged a homogeneity so that the passed reactant gas may flow down by the uniform rate of flow. Therefore, X region and Z region differ in the rate of flow, and the reactant gas introduced into the space region S from two or more gas supply openings 16 and 16 of a fission reactor crowning flows down them at the same time it passes each gas eye of a straightening vane 17 and is rectified. Moreover, the boundary of X region and Z region where a numerical aperture is small where a numerical aperture is big makes mostly in agreement the periphery edge P of the projection configuratio in which the rotation substrate supporter carried out the orthographic projection as mentioned above, or is located in th direction of an inner wall of the kiln from the periphery edge P. For this reason, as described above, flowing-down supply of the reactant gas which passes gas eye 17a by the side of a core which was mostly located above the rotation substrate supporter and has been arranged at homogeneity from the periphery edge P of a projection configuration is carried out by the uniform predetermined rate of flow (flow rate) on the wafer substrate W front face on the rotation substrate supporter 12. Since a numerical aperture is size, the reactant gas which, on the other hand, passes gas eye 17b of X region located outside the projection configuration periphery edge P becomes more abundant than the capacity of gas eye 17a passage of Z region, and will flow down by the quick rate of flow.

[0019] Using the vapor growth equipment of this invention constituted as mentioned above, the wafer substrate W is laid on the rotation substrate supporter 12, and the inside of a fission reactor 11 is exhausted after that with the exhaust air control unit connected to exhaust ports 15 and 15, for example, material gas, such as silane gas, is supplied, and furnace internal pressure is adjusted to 20 - 50torr. On the other hand, a motor is worked, the rotation drive of the revolving shaft 13 is carried out, the rotation substrate supporter 12 is rotated, and the wafer substrate W on it is rotatec by coincidence. The heating temperature up of the wafer substrate W on the rotation substrate supporter 12 is carried out to about 900-1200 degrees C at a heater 14 at coincidence. Moreover, the reactant gas which consists of material gas and carrier gas is supplied to the space region S in a fission reactor 11, controlling a flow rate from the gas supply openings 16 and 16 to coincidence predetermined. From two or more gas supply openings 16 and 16, momentum and pressure distribution are equalized, further, the gas eyes 17a and 17b by which two or more drilling was carried out with the numerical aperture according to a predetermined region are passed to a straightening vane 17, it is rectified, and the gas stream supplied to the space region S flows down. Moreover, the reactant gas after straightening-vane passage serves as the predetermined rate of flow according to the capacity and the numerical aperture which are

supplied. Furthermore, since gas eye 17a of the diameter of the same is drilled equally, it can be flowed down reactant gas on a wafer substrate by the almost uniform gas flow rate, and it can make homogeneity carry out vapor growth of the homogeneous thin film on a wafer substrate in Z region by the side of a core as mentioned above than the periphery marginal P neighborhood of the projection configuration of a rotation substrate supporter.

[0020] As above-mentioned, the rates of flow differ in the external region (X region) and the central region (Z region) which have a large and small difference in a numerical aperture bordering on the periphery marginal P neighborhood o the projection configuration of a rotation substrate supporter, and the reactant gas which passes the straightening vane of the fission reactor of this invention produces inclination in gas flow rate distribution in a fission reactor. For example, as the velocity distribution of the gas elementary-stream Fig. of (A) of drawing 1 and (B), (C), and (D) showed, a reactant gas flow rate flows [in X region of the fission reactor wall circumference with a big numerical aperture] down a reactant gas style almost perpendicularly [and] at the high rate of flow. The dancing going-up phenomenon of a gas stream rise of meeting the fission reactor wall observed with the above mentioned conventional fission reactor is controlled by the quick gas stream of the rate of flow formed around this fission reactor wall, and generating of a gas vortex is also prevented according to it. Furthermore, since there is no rise of temperature up gas, it can also be prevented that fission reactor bashful phase temperature goes up. Therefore, the homogeneous nucleation o the thin film formation component by the material gas in reactant gas is controlled, and the particle generated in a furnace bashful phase decreases. Therefore, the particle generated in the gaseous phase adheres to a fission reactor wall a maintenance cycle is shortened, or it adheres to a wafer and un-arranging in conventional methods, such as bringing about direct deterioration of wafer quality as adhesion particle, is prevented [**** / making a crystal defect occur].

[0021] On the other hand, the reactant gas which circulates the area within Z by the side of the core of a straightening vane passes gas eye 17a which is compared with X region and by which the numerical aperture has been arranged smal almost equally, flows down in the center section by the rate of flow looser than the rate of flow of X region, and uniform almost perpendicularly, is supplied on a wafer substrate, and can form a uniform thin film like a conventional method. As shown in (A) of drawing 1 , by the outermost periphery of Z region, since X region is adjoined, it is influenced of the reactant gas which flows into the large quantity of X region, and a gas elementary stream is once crooked so that it may be pushed in the direction of a core. However, since there is no generating of a gas dancing going-up phenomenon or a gas vortex in X region of the inner-wall-of-the-kiln circumference, circulating in the direction of a path on a wafer substrate, flowing in the direction of a path with the reactant gas which flowed down the center section of the Z region almost perpendicularly, forming a gas stream transition layer, and circulating to an exhaust port 15 after that, so that it may be drawn in by the gas stream which circulates X region is checked. Therefore right above [wafer substrate] on a rotation substrate supporter, the gas circulation to the direction of a path is barred, i is carried out smoothly without things, and gas circulates from the core of a wafer substrate equally to the periphery section. For this reason, re-taking in of the dopant in the wafer substrate periphery section does not occur. Therefore, the field internal resistance value distribution of the wafer substrate with which the uniform thin film was formed of vapor growth also becomes uniform, and the wafer substrate of high quality can be obtained.

[0022] Each rate of flow VX of the reactant gas which passes the gas eye of the external region (X region) of a straightening vane, and other fields (Z region), and flows down in this invention And VZ By adjusting suitably a diameter of opening, the number of arrangement, etc. of a gas eye of a straightening vane, and making a numerical aperture predetermined as described above, VX is VZ. It is set up so that it may become large. desirable -- the rate of flow VX of X region The rate of flow VZ of Z region a ratio (VX/VZ) -- 5-30 -- it sets up so that it may be preferably set to 10-20. It occurs [the dancing going-up phenomenon and gas vortex of a gas stream to the upper part] that this rate-of-flow ratio is less than five in accordance with a fission reactor wall and is not desirable. It is not desirable in order to check the gas flow which, on the other hand, forms the transition layer from the center of the rotation substrate on a rotation substrate supporter to the periphery section since the gas flow rate of X region (external region) of the furnace wall circumference is too quick when 30 is exceeded. As for Z region gas flow rate, in this invention, it is desirable to consider as 0.05 - 0.7 m/s generally. Since the gas stream of the outermost part of Z region on the rotation substrate supporter which adjoins X region as they are less than 0.05 m/s is not only pushed on a central site, but the gas flow from the center of the rotation substrate on a rotation substrate supporter to the periphery section is checked, i is not desirable. Moreover, even if it exceeds 0.7 m/s, the above effectiveness is not acquired more. The gas dancing going-up phenomenon and gas vortex which had produced the vapor growth equipment of this invention in the conventional method by the rate of flow of 0.7 or less m/s to having passed reactant gas in s in 0.7-1.0 usually comparatively quickm /with conventional vapor growth equipment can be prevented, it is not necessary to pass carrier gas so much, and practicality is very high industrially. In this case, the gas flow rate of X region is Above VX / VZ. What is necessary is just to set it as predetermined by the ratio.

[0023] Drawing 4 is the outline cross-section explanatory view of other examples of the vapor growth equipment of this invention. The space region formed in drawing 4 with the head-lining section and the straightening vane 17 of the upper part in a fission reactor 41 is the periphery space region SX by the dashboard 18. Central space region SZ It is constituted like the equipment of drawing 1 except 2 ****s being carried out. In addition, the same sign is given to the same member as drawing 1 , and explanation is omitted. A dashboard 18 is arranged in a boundary with the boundary of the external region where the numerical aperture of the straightening vane shown in said drawing 1 generally changes, and other fields, i.e., the external region where a numerical aperture is large and the reactant gas rate of flow i quick, (X region), and other late fields (Z region) of the reactant gas rate of flow where a numerical aperture is small, and the spacing width of face from the furnace inner circle wall of an external region of it is the same as that of the above. Usually, it is located and arranged near [periphery marginal P] the orthographic-projection configuration to the straightening vane 17 of the rotation substrate supporter 12. space region SX **** -- the gas supply openings 16 and 1(-- moreover, space region SZ **** -- the gas supply opening 19 arranges separately, respectively -- having -- still more separate gas supply system GX to the gas supply openings 16, 16, and 19 And GZ It is connected separately, respectively. each space region SX classified by the dashboard 18 by this And SZ **** -- if reactant gas, such as material gas and carrier gas, can be supplied separately, and is required and it will be the class of reactant gas, and mixed gas -- the mixing ratio -- various conditions of supply, such as a rate, temperature at the time of gas supply, a pressure, and a flow rate, can be changed, and can be supplied. For example, in drawing 4 , like drawing 1 , in X region, as for the straightening vane 17, gas eye 17a of a minor diameter is drilled in gas eye 17b of a major diameter ir Z region so that numerical apertures may differ bordering on a dashboard 18. moreover, space region SX which drilled the gas eye equally and was classified by the dashboard 18 in the numerical aperture of the straightening-vane 17 whol region in this method And SZ Gas supply system GX And GZ from -- the reactant gas which consists of thin film formation material gas and carrier gas by quantity of gas flow different, respectively is supplied, and you may make it the gas stream after passing a straightening vane 17 serve as the rate of flow quicker than Z region in X region in a fission reactor Moreover, only carrier gas can also be circulated in X region.

[0024] Drawing 5 is the outline cross-section explanatory view of other examples of the vapor growth equipment of this invention. In drawing 5 , the inside of the fission reactor 51 in the air is classified into the upper part 1 and the lower part 2, and the upper part 1 is formed more thinly than the lower part 2. up bore D1 Lower bore D2 small -- D1 -< -- D2 it is -- the lower limit section B of the upper limit section U of the lower part 2 of a major diameter and the upper part 1 of a minor diameter is connected by the connection section 20, and except that the space in a furnace continues, it is constituted like the equipment of drawing 1 . In addition, the same sign is given to the same member as drawing 1 , and explanation is omitted. It sets to the fission reactor 51 of drawing 5 , and the rotation substrate supporter 12 has the difference of elevation (H) more nearly predetermined than the fission reactor up lower limit B in a top face, is located caudad, and is arranged. The side-attachment-wall side of the fission reactor upper part 1 is usually formed at right angles to the side-attachment-wall side of the lower part 2, and parallel, and is perpendicularly formed to rotation substrate supporter 12 top face. Although usually formed horizontally, the connection section 20 of the above-mentioned up lower limit B and the lower upper limit U is not restricted especially, and may be formed the letter of an inclination, and in the shape of a curved surface. In the fission reactor 51 constituted as mentioned above, by making quick the gas flow rate in the external region in a furnace (X region) like the fission reactor 11 of drawing 1 bordering on the periphery marginal P neighborhood of the projection configuration to the straightening vane 17 of the rotation substrate supporter 12 While generating of the dancing going-up phenomenon of a gas stream or a gas vortex i controlled, it is the bore D1 of the furnace upper part 1. From it being thin The dancing going-up phenomenon to the upper part of a gas stream can be controlled further, generating of gaseous-phase particle is controlled in multiplication adhesion in a furnace wall and the effect on a wafer substrate can be prevented, the quality of a thin film formation wafer substrate improves, a maintenance cycle also serves as a long period of time, and a industrial advantage is remarkable.

[0025] Moreover, it sets to the fission reactor of drawing 5 , and they are the fission reactor up bore D1, the lower bore D2, and the path DS of the rotation substrate supporter 12. It is desirable to have the respectively following ratio relation. For example, D1 It is larger than a wafer diameter and is (1) D2 / D1. A ratio is 1.2 (D2 / D 1>=1.2) or more. D1 When smaller than a wafer diameter, it is for the crystal defect which the particle which dropped out of furnace up internal surface tends to adhere to the wafer substrate laid on the rotation substrate supporter 12, and is measured as LPD (wafer surface laser scatterer (particle is included)) as a result to increase. Moreover, it is because the non-contact thermometry by the infrared radiation of the wafer substrate periphery section usually performed at a gaseous-phase thin film growth process becomes difficult. On the other hand, it is D2 / D1. If a ratio is larger than 1.2, even if the gas flow rate ratio of X region of a reaction zone and Z region is comparatively small, the dancing going-up phenomenon

to the upper part of a gas stream can be controlled. (2) D1 / DS A ratio is in 0.7-1.2 (0.7 <=D1/DS <=1.2). D1 / DS If ratios are 0.7-1.2, even if the gas flow rate ratio of X region of a fission reactor and Z region is comparatively small, th dancing going-up phenomenon to the upper part of a gas stream can be controlled. D1 / DS If a ratio is smaller than 0.7, the particle in which the wall surface of the upper part 1 approached too much the wafer substrate laid on the rotation substrate supporter 12, and fell out from the inner-wall-of-the-kiln side will become easy to adhere to a wafer substrate. Therefore, the above D1 It is for the crystal defect measured as LPD to increase like the case of being smalle than a wafer substrate diameter, and for the quality of a thin film formation wafer substrate to deteriorate. On the other hand, they are D1 / DS. Even if a ratio makes it larger than 1.2, the improvement in the effectiveness beyond it is not obtained. (3) D2 / DS A ratio is 1.2 (D2/DS >=1.2) or more. D2 / DS If a ratio is smaller than 1.2, since the gas stream of Z region which circulated the rotation substrate supporter 12 top will stop being able to flow to an exhaust pipe easily smoothly, it is for particle to adhere to the fission reactor wall which counters rotation substrate supporter 12 outside, or for a unconverted gas to react in the lower part of the rotation substrate supporter 12, for a thin film formation component to deposit in the wall of the fission reactor lower part 2, and for a maintenance cycle to short-period-ize.

[0026] Furthermore, as mentioned above, the top face of the rotation substrate supporter 12 has the difference of elevation H predetermined in a lower part from the lower limit B of the fission reactor upper part 1, and the fission reactor 51 of drawing 5 is arranged. This difference of elevation H has that desirable of ** so that gas streams, such as the transition layer which the gas stream in Z region on the rotation substrate supporter 12 forms, i.e., the material gas supplied by passing gas eye 17a of a straightening vane 17 as the arrow head showed to drawing 5 , may usually become larger than the thickness (T) of the gas reservoir which has a vector from a core to the direction of a periphery on the rotation substrate supporter 12. If this difference of elevation H is smaller than the transition layer thickness T, the gas stream from the core of the wafer substrate W on the rotation substrate supporter 12 to the direction of a path will be checked by the lower limit B of the fission reactor upper part 1, the dancing going-up phenomenon to the upper part will arise along the side face of the fission reactor upper part 1, and generating of a gas vortex will be promoted. Moreover, as for rotation substrate supporter 12 top face, it is desirable that it is parallel to the fission reactor upper par 1 and the connection section 20 of the lower part 2.

[0027] Moreover, in the general fission reactor used from the former, although transition layer thickness T of the gas stream on the above-mentioned rotation substrate supporter 12 mainly changes with the rotational frequencies of the class of controlled atmosphere in a fission reactor, fission reactor internal pressure, and a rotation substrate supporter, i is computable by the following formula (1). Generally the following type (1) is shown by hydrodynamics.

T=3.22(nu/omega) 1/2 (1)

(However, nu displays the coefficient of kinematic viscosity (mm2/s) of the reactant gas in a fission reactor, and omeg displays a rotational angular velocity (rad/s), respectively.) omega shall take the minimum value under thin film formation operation with vapor growth equipment in this case. For example, material gas is silane gas, carrier gas is hydrogen gas, and when the rotational frequency of a rotation substrate supporter is 500 - 2000rpm (52 - 209 rad/s), the transition layer thickness T is set to about 5-50mm. Therefore, it is desirable to arrange so that a rotation substrate supporter top face may be located by the bigger difference of elevation H from the lower limit B of the fission reactor upper part 1 of a minor diameter than the above-mentioned T value. The gas flow from the core on a wafer substrate to a periphery becomes still smoother by this, there is no adhesion of the particle of a thin film formation raw material in an inner wall of the kiln, and the thin film formation wafer obtained does not have a defect in a crystal phase, and a uniform thin film is formed.

[0028] Drawing 6 is the outline cross-section explanatory view of other examples of the vapor growth equipment of this invention. While two or more drilling of the rectification effluence-of-gas hole 20a for a fission reactor 61 being classified into the minor diameter upper part 1 and the major-diameter lower part 2 up and down, and flowing the gas for rectification into the connection section 20 of the upper part 1 and the lower part 2 in drawing 6 is carried out The connection section 20 in which the peripheral face whole region of the fission reactor upper part 1 was surrounded, and rectification effluence-of-gas hole 20a was drilled in duplex annular by nothing and the hollow annular section 21 is surrounded airtightly, and it is constituted like the equipment of drawing 5 except having formed the rectification gas supply opening I in the hollow annular section 21. In addition, the same sign is given to the same member as drawing 5 , and explanation is omitted. In the fission reactor 51 of drawing 6 , in order to perform smoothly flow to the exhaust ports 15 and 15 of a unconverted gas, the gas for rectification can be flowed out of rectification effluence-of-gas hole 20a drilled in the above-mentioned connection section 20. Generally the above-mentioned carrier gas is used and the gas for rectification flows out the usually same gas as the carrier gas introduced from the gas supply openings 16 and 16 of a fission reactor. By this rectification effluence of gas, the unconverted gas after it reached the wafer substrate W

and thin film growth was presented by the synergistic effect with the reactant gas of the high rate of flow of X region circulates a rotation substrate supporter 12 periphery side, and is smoothly discharged from exhaust ports 15 and 15, without producing the dry area of a gas vortex or a gas stream, and a deposit of the thin film formation component in the fission reactor lower part does not have it, either, and it can attain protraction of the maintenance cycle of a furnace

[0029] In the fission reactor 61 of drawing 6 , it is desirable to flow out so that the ratio (VI/VX) of the rate of flow (VX) of the reactant gas of X region and the rate of flow (VI) of the gas for rectification from rectification effluence-of gas hole 20a may be set to 0.05-2 (0.05 <=VI/VX <=2). By flowing out the gas for rectification from rectification effluence-of-gas hole 20a of the connection section 20, the flow of the reactant gas on a rotation substrate supporter an the flow of the unconverted gas from a rotation substrate supporter periphery side to between fission reactor lower hollow become smooth, without producing a gas vortex and a gas flow dry area, and a crystal defect can obtain the thin film formation wafer substrate of little homogeneous high quality so that VI / VX ratio may become above-mentioned within the limits. VI/VX The effectiveness of passing the gas for rectification from 20a of the path expansion part of the fission reactor lower part located in rotation substrate supporter 12 outside as it is less than 0.05 is not acquired. Moreover, VI/VX If 2 is exceeded, since the gas flow rate in the path expansion part of rotation substrate supporter 12 outside becomes too much early, the smooth gas flow from the core on the rotation substrate supporter 12 to a periphery is checked and homogeneous thin film growth cannot be performed in homogeneity thickness, it is not desirable.

[0030]

[Example]

examples 1-3 -- the cross section constituted like the fission reactor in the air shown in said drawing 1 -- the thin film was formed on the wafer substrate using circular vapor growth equipment. The spacing width of face X from the fissio reactor wall of the external region (X region) where the straightening vane 17 of a numerical aperture is large The difference Y of the radius (RD) of a straightening vane 17 and the radius of the rotation substrate supporter 12, i.e., the radius of the orthographic drawing form to a straightening vane 17, (RP) The boundary of X region and Z region was set up so that it might become the ratio (X/Y) shown in Table 1, and with gas eye 17a of the diameter shown in Table 1 respectively, and a numerical aperture (%), it punctured, respectively with 17b of a diameter and the numerical apertur (%) which were shown in Table 1, formed in X region in Z region of a straightening vane, and arranged in the fission reactor. as material gas -- SiH4 gas -- as carrier gas -- H2 gas -- moreover -- as a dopant -- diboron hexahydride (B-2 H6) -- H2 The flow rate was adjusted and supplied so that it might become the ratio (VX/VZ) which showed the rate o flow (VX) of the reactant gas of X region, and the rate of flow (VZ) of Z region for the gas made to contain 0.1 ppm among gas in Table 1. Moreover, the rotational frequency of reaction temperature, reaction pressure, and a rotation substrate supporter was collectively shown in Table 1.

[0031] It is B-2 H6 on a silicon wafer under the vapor growth conditions shown in Table 1. Vapor growth of a dopant silicon thin film was performed. After forming a vapor growth thin film, visual observation of the particle adhesion of the fission reactor wall of the used gaseous-phase thin film growth equipment was carried out, and the some were shown in Table 1. Moreover, the number of LPD 0.135 micrometers or more was measured using the surfboard scan 6200 by the ten call company about the description of the crystal phase of the acquired thin film formation wafer substrate side, and the result was shown in Table 1 as the number per wafer. Moreover, the thickness of a formation thin film was measured by the infrared interference thickness gage, and it asked for the maximum thickness (Fmax) an the minimum thickness (Fmin), and the homogeneity of thin film thickness was computed as (Fmax-Fmin)/(Fmax+Fmin) x100, and was shown in Table 1. Moreover, the resistance of the obtained thin film formation wafer substrate was measured using the CV method, the maximum (Rmax) and minimum value (Rmin) were calculated, and the homogeneity of the resistance by dopant incorporation was computed as (Rmax-Rmin)/(Rmax+Rmin) x100, and was shown in Table 1.

[0032] The thin film was formed on the wafer substrate using the vapor growth equipment of the cross-section round shape constituted like the fission reactor in the air shown in example 4 aforementioned drawing 4 . The straightening vane 17 arranged that in which the whole has the numerical aperture shown in Table 2. Moreover, a dashboard 18 is installed in the region between straightening-vane absentminded at the circle rim section of the same path as that of a rotation substrate supporter, and it is SX about an up space region. A region and SZ It classified into the region two times. SZ On the conditions which showed the same reactant gas as an example 1 in Table 2, it supplied, flows into a region, and is SX. In a region, it is H2. It supplies by the flow rate which showed gas in Table 2, and is B-2 H6 on a silicon wafer. Vapor growth of a dopant silicon thin film was performed. The result measured like [substrate / the observation in a fission reactor and / which was obtained / thin film formation wafer] the example 1 was shown in

Table 2.

[0033] examples 5-6 -- the cross section constituted like the fission reactor in the air shown in said drawing 5 (example 5) and drawing 6 (example 6) -- the thin film was formed on the wafer substrate using circular vapor growth equipment. Equipment was formed on the conditions shown in Table 2. At an example 6, it is H2 to Y region from the connection section 20. By the flow rate which showed gas in Table 2, it adjusts and supplies so that it may become the ratio (VX/VY) which showed the rate of flow (VX) of the reactant gas of X region, and the rate of flow (VY) of Y region in Table 2, and it is B-2 H6 on a silicon wafer. Vapor growth of a dopant silicon thin film was performed. The result measured like [substrate / the observation in a fission reactor and / which was obtained / thin film formation wafer] the example 1 was shown in Table 2.

[0034]

[Table 1]

		実施例1	実施例2	実施例3
気相成長条件	温度 (℃)	1000	1000	1000
	圧力 (torr)	40	40	40
	SiH_4ガス流量 (l/min)	0.3	0.3	0.3
	H_2流量 (l/min)	30	30	30
	B_2H_6含有H_2ガス流量 (l/min)	0.01	0.01	0.01
	回転体回転数 (rpm)	2000	2000	2000
	V_X /V_Z 比	20	10	30
装置条件	X/Y比	0.05	1.0	0.02
	X域のガス 孔スリット幅 (mm)	2.25	45	0.9
	X域の開口率 (%)	90	90	90
	Z域のガス 孔径 (mm)	1	3	1
	Z域の開口率 (%)	0.115	7.31	0.035
結果	膜厚均一性	3.92	4.11	4.35
	抵抗値均一性	6.12	6.35	6.58
	LPD (> 0.135 μm) (個)	498	526	672
	反応炉下部でのパーティクル析出	少	少	少

[0035]

[Table 2]

		比較例1	比較例2	比較例3	比較例4
気相成長条件	温度 (℃)	1000	1000	1000	1000
	圧力 (torr)	40	40	40	30
	SiH_4ガス流 (l/min)	0.3	0.3	0.3	2
	H_2流量 (l/min)	30	30	30	200
	B_2H_6含有H_2ガス流量 (l/min)	0.01	0.01	0.01	0.07
	回転体回転数 (rpm)	2000	2000	2000	2000
	V_X/V_Z比	2	20	–	–
装置条件	X/Y比	0.8	1.3	–	–
	X域のガス 孔スリット幅 (mm)	3（孔径）	58	–	–
	X域の開口率 (%)	33	90	–	–
	Z域のガス 孔径 (mm)	3	3	–	–
	Z域の開口率 (%)	9.70	5.66	–	–
結果	膜厚均一性	8.69	19.36	8.71	0.98
	抵抗値均一性	31.07	37.45	31.15	8.33
	LPD (>0.135 μm) (個)	33269	89374	33707	1087
	反応炉下部でのパーティクル析出	多	多	多	少

[0039] When the reactant gas rate of flow of X region of the predetermined width of face of the fission reactor wall circumference is made quicker than central Z region by the predetermined ratio so that more clearly than the above-mentioned example and the example of a comparison, a thin film formation wafer substrate with the LPD number of the crystal phase of the thin film formation wafer substrate front face obtained good at 1000 or less is obtained. If the rate-of-flow ratio compares carrier gas with this example and the example 3 of a comparison circulated similarly by the example 1 of a comparison lower than a predetermined ratio, and the conventional method, and this LPD number is or less about 1 / 50 and compares a field larger than predetermined width of face with the example 2 of a comparison which passed the quick reactant gas of the rate of flow, it is or less about 1 / 130. Moreover, the fact of are also 1000 or more pieces shows that the thin film formation by the vapor growth of this invention is excellent with the conventional method also in the example 4 of a comparison which circulated carrier gas by part for 200l./. Moreover, although the homogeneity of the thin film thickness formed is also lower than the thing of the example 4 of a comparison, it is fitness, it is clear homogeneity's of resistance to excel, even if it compares with the example 4 of a comparison, and the thin film formation wafer substrate of high quality can be obtained, without using carrier gas so much.
[0040]
[Effect of the Invention] The reactant gas style introduced to a fission reactor changes the rate of flow in a center section and the periphery section, and the vapor growth equipment of this invention can prevent the dancing going-up phenomenon to the upper part [make / it / the gas flow rate in the periphery section become large] of the reactant gas which was producing various un-arranging. Therefore, the temperature rise of reactant gas can be inhibited, the

		実施例4	実施例5	実施例6
気相成長条件	温度 (℃)	1000	1000	1000
	圧力 (torr)	40	40	40
	SiH_4ガス流量 (l/min)	0.3	0.3	0.3
	H_2流量 (l/min)	10	30	30
	B_2H_6含有H_2ガス流量 (l/min)	0.01	0.01	0.01
	回転体回転数 (rpm)	2000	2000	2000
	V_X / V_Z 比	10	10	10
	連結部またはS_X：流量 (l/min)	S_X : 80	–	20
	V_Y / V_Z 比	–	–	1
装置条件	X/Y比	–	1.0	1.0
	D_1 / D_S 比	–	1.0	1.0
	D_2 / D_1 比	–	1.25	1.25
	D_2 / D_S 比	–	1.25	1.25
	H (mm)	–	50	50
	X域のガス 孔スリット幅 (mm)	3	45	45
	X域の開口率 (%)	7.31	90	90
	Z域のガス 孔径 (mm)	3	3	3
	Z域の開口率 (%)	7.31	7.31	7.31
結果	膜厚均一性	3.99	1.04	0.83
	抵抗値均一性	6.20	4.93	4.27
	LPD (>0.135 μm (個)	508	116	85
	連結部でのパーティクルの析出	–	少	無
	下部でのパーティクルの析出	少	少	少

[0036] Example of comparison 1-2VX / VZ About the example 1 of a comparison smaller than predetermined, a straightening vane is formed on the conditions shown in Table 2. Moreover, except having formed the straightening vane on the conditions shown in Table 2, and having arranged in the fission reactor about the example 2 of a comparison with a larger X/Y ratio than predetermined It is B-2 H6 on a silicon wafer like an example 1 using the vapor growth equipment constituted like the fission reactor of an example 1. Vapor growth of a dopant silicon thin film was performed. Then, the result similarly measured about the observation in a fission reactor and the obtained thin film formation wafer substrate was shown in Table 3.
[0037] the examples 3-4 of a comparison -- the bottom of the vapor growth reaction condition shown in Table 2 using the vapor growth equipment with which the numerical aperture of a straightening vane was equally formed, and was constituted like the fission reactor of the conventional gaseous-phase thin film growth equipment shown in said drawing 7 -- an example 1 -- the same -- carrying out -- a silicon wafer front-face top -- B-2 H6 The dopant silicon thin film was formed. Then, the result similarly measured about the observation in a fission reactor and the obtained thin film formation wafer substrate was shown in Table 3.
[0038]
[Table 3]

homogeneous nucleation of thin film formation material gas is controlled, and the particle generated in a gaseous phase decreases. Therefore, since it adheres to a fission reactor wall, and a maintenance cycle is shortened or the particle which adheres to a wafer and causes a crystal defect decreases, the thin film formation wafer substrate of high quality can be manufactured. Moreover, the gaseous-phase thin film growth by the gaseous-phase thin film growth equipment of this invention In order to circulate smoothly, without stagnating also on the wafer substrate which there is also no generating of particle about the gas flow in a fission reactor, and it can maintain to stability, without producing a turbulent flow and channeling, and the inside of a fission reactor can be circulated smoothly, and forms a thin film, It does not happen, but becomes uniform [the field internal resistance value of the wafer substrate obtained], and the reuptake of a dopant etc. can obtain a wafer substrate suitable as an object for high integration.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] The reactant gas style introduced to a fission reactor changes the rate of flow in a center section and the periphery section, and the vapor growth equipment of this invention can prevent the dancing going-up phenomenon to the upper part [make / it / the gas flow rate in the periphery section become large] of the reactant gas which was producing various un-arranging. Therefore, the temperature rise of reactant gas can be inhibited, the homogeneous nucleation of thin film formation material gas is controlled, and the particle generated in a gaseous phase decreases. Therefore, since it adheres to a fission reactor wall, and a maintenance cycle is shortened or the particle which adheres to a wafer and causes a crystal defect decreases, the thin film formation wafer substrate of high quality can be manufactured. Moreover, the gaseous-phase thin film growth by the gaseous-phase thin film growth equipment of this invention In order to circulate smoothly, without stagnating also on the wafer substrate which there is also no generating of particle about the gas flow in a fission reactor, and it can maintain to stability, without producing a turbulent flow and channeling, and the inside of a fission reactor can be circulated smoothly, and forms a thin film, It does not happen, but becomes uniform [the field internal resistance value of the wafer substrate obtained], and the reuptake of a dopant etc. can obtain a wafer substrate suitable as an object for high integration.

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